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Spinning Convection: Particle-induced Secondary Flow in Straight Microchannels HAMED AMINI, ELODIE SOLLIER, DINO DI CARLO, University of California, Los Angeles — In microfluidic systems, flow is generally approximated with Stokes flow and inertial forces are assumed negligible. However, at finite Reynolds number (small, yet non-zero), inertial forces have been shown to be useful, for instance by causing randomly distributed particles to order on specific lateral equilibrium positions in a confined flow. To further study these inertial effects at the microfluidic scale, we investigated the local disturbances induced by spinning particles in straight microchannels. We observe, numerically and experimentally, unexpected net cross-stream disturbances that generate a unique secondary flow pattern, which resembles the well-known Dean flow in curved channels. This behavior requires fluid inertia and micro-particles offset from the channel center, spinning due to the local shear rate across the particle. This phenomenon provides a novel technique for fluid transfer and solution switching in microsystems. Compared to other microfluidic mixing approaches the technique requires a simple channel geometry, with no external forces for operation, enabling biological applications in which the cells present within the flow themselves can induce the fluid transfer required for labeling, lysis, and other high-throughput sample preparations.

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